DEVELOPMENT OF POLYETHERSULFONE–POLY VINYLIDENEFLUORIDE (PES-PVDF) THIN FILM COMPOSITE MEMBRANE FOR CO_2/N_2 GAS SEPARATION

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SUPERVISOR DECLARATION

"I/we hereby declare that I/we have read this thesis and in my/our opinion this thesis has fulfilled the qualities and requirements for the award of Degree of Bachelor of Chemical Engineering (GasTechnology)"

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Date : 18 February 2013

STUDENT DECLARATION

I declare that this thesis entitled "Development of Polyethersulfone–Poly Vinylidenefluoride (PES-PVDF) Thin Film Composite Membrane for Co_2/N_2 Gas Separation" is the result of my own research except as cited in references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree."

Signature : ……

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Date : 18 February 2013

Special dedications to my mum and dad that always inspire, love and stand beside me,

and to my beloved friend.

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LIST OF ABBREVIATIONS

PES	-	Polyethersulfone
PVDF	-	Poly (vinylidene fluoride)
PEG	-	Polyethylene Glycol
PS	-	Polysulfone
PP	-	Polypropelyene
SEM	-	Scanning Electron Microscope
FTIR	-	Fourier Transform Infrared
N_2	-	Nitrogen
CO_2	-	Carbon dioxide
NMP	-	N-methyl-2-pyrrolidone
TFC	-	Thin Film Composite
UF	-	Ultrafiltration
MF	-	Microfiltration
RO	-	Reverse Osmosis

LIST OF SYMBOL

P_i	-	Permeability for Gas component
Q	-	Volumetric Gas Flowrate
A	-	Effectiveness Membrane Area
ΔP	-	Pressure in System
l	-	Membrane Thickness
α	-	Selectivity
^oC	-	Digree Celcius
K	-	Kelvin

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PEMBENTUKAN POLYETHERSULFONE–POLY VINYLIDENEFLUORIDE (PES-PVDF) BAGI KOMPOSIT FILEM NIPIS (TFC) UNTUK PEMISAHAN GAS KARBON DIOKSIDA ($C0_2$) DAN GAS NITROGEN (N_2)

ABSTRAK

Tujuan utama kajian ini adalah untuk menghasilkan komposit filem nipis (TFC) dengan menggunakan polietersulfon-poli (vinylidenefluoride) (PES PVDF) untuk pemisahan gas CO_2/N_2. Tujuan lain adalah untuk mengkaji segmen pada Poli (vinylidenefluoride) (PVDF) sebagai lapisan sokongan pada membran untuk meningkatkan kadar kebolehtelapan dan keterpilihan untuk pemisahan gas. Pertama, membran sokongan mestilah terdiri daripada vinylidenefluoride poli (PVDF), N-metil-2-pyrolidone (NMP) dan sedikit peratusan air. Larutan polymer dan pelarut yang merupakan larutan bagi sokongan untuk membran TFC telah disediakan dengan menggunakan kaedah konvensional dan elektrik pemanasan. Larutan untuk lapisan atas untuk kajian ini terdiri daripada PES, N-metil-2-pyrolidone (NMP) dan air atau heksana. Kemudian, larutan PES akan disalut pada PVDF membran yang telah siap dituang dan diratakan dengan menggunakan rod kaca. Lapisan untuk salutan dilaksanakan di atas plat kaca. Ujian penyerapan dijalankan dengan menggunakan gas karbon dioksida (CO_2) tulen dan gas nitrogen (N_2) tulen melalui TFC membran untuk melihat kebolehtelapan dan pemilihan gas masing-masing. Prestasi membran ini diukur berdasarkan kepada kebolehtelapan dan pemilihan untuk pemisahan gas CO_2/N_2. PVDF telah bertindak sebagai polimer asas, manakala N-metil Pyrrolidone (NMP) telah digunakan sebagai pelarut. TFC membran dianalisis menggunakan kaedah Mikroskop Imbasan Elektron (SEM) dan Sinaran inframerah transformasi Fourier (FTIR) untuk menentukan struktur dan kumpulan berfungsi yang wujud dalam membran. Gabungan antara liang-liang pada sokongan membran dan kepekatan larutan penyalut akan mencapai tahap terbaik dari segi kebolehpilihan dan kebolehtelapan masing-masing. Gas karbon dioksida (CO_2) perlu dipisahkan daripada gas bahan api untuk mengurangkan pelepasan gas karbon dioksida (CO_2) yang boleh menyebabkan isu-isu alam sekitar seperti pemanasan global, perubahan iklim dan kesan rumah hijau.

DEVELOPMENT OF POLYETHERSULFONE–POLY VINYLIDENEFLUORIDE (PES-PVDF) THIN FILM COMPOSITE MEMBRANE FOR CO_2/N_2 GAS SEPARATION

ABSTRACT

The main purpose for this study is to produce thin film composite (TFC) by using Polyethersulfone –poly (vinylidenefluoride) (PES–PVDF) for CO_2/N_2 gas separation. The other purpose is to investigate the segment of Poly (vinylidenefluoride) (PVDF) as the membrane support to improve the rate of permselectivity for gas separation. First, the support membrane was development consist of poly vinylidenefluoride (PVDF), N-methyl-2-pyrolidone (NMP) and water. The dope solution which is solution for support membrane for TFC membrane was prepared by using conventional and electrical heating method. The coating solution developed in this research consists of PES, N-methyl-2-pyrolidone (NMP) and water or hexane. Then, the PES solution was coated on the PVDF casted by using glass rod. The coating layer was performed on the glass plate. Permeation test was carried out by testing pure of CO_2 and N_2 through the TFC membrane to see the permeability and selectivity. We measure the performance of this membrane based on terms of permeability and selectivity for the CO_2/N_2 gas separation. PVDF was employed as a base polymer, while N-methyl pyrrolidone (NMP) was used as a solvent. The prepared TFC membrane was characterized using Scanning Electron Microscope (SEM) and Fourier Transform Infrared Radiation (FTIR) method to determine the structure and functional group of our membrane. The combination of support porosity and concentration of coating solution could lead to achieve the optimum of selectivity and permeability respectively. The CO_2 should be separated from the fuel gas to reduce the CO_2 emission that can cause of environmental issues like global warming, climate change and greenhouse effect.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

As energy costs rise, membrane technology for separating gases is likely to play an increasingly important role in reducing the environmental impact and costs of industrial processes. In addition, gas separation membrane units are smaller than other types of plants, like amine stripping plants, and therefore have relatively small footprints. A small footprint is important in environments such as offshore gas-processing platforms. Currently, gas separation membranes are most widely used in industry for CO_2 and water removal from natural gas. At the moment, the most widely used membrane materials for gas separation are polymers. Composite membrane including thin film composite (TFC) can be prepare by using dry and wet process. For example, in the dry process, there are the vapor depositions, the plasma-initiated polymerization and the radiation polymerization methods. In the wet process, there are polymer coating and spreding on water surface. Currently, among the types of support used for dip-coating are mostly Polysulfone (PSF) or Polyethersulfone (PES). However,

Polypropelyene (PP) and polyvinylidenefluoride (PVDF) are very attractive materials as a hydrophobic support for forming a TFC membrane due to its high durability and resistance to chemicals, pH variations, and a substantially wide range of solvents. The economics of a gas separation membrane process is largely determined by the membrane's transport properties, which are permeability and selectivity for a specific gas in a mixture. Ideally, membranes should exhibit high selectivity and high permeability. For most membranes, however, as selectivity increases, permeability decreases, and vice versa.

1.2 PROBLEM STATEMENT

Membrane gas separation is a dynamic and rapidly growing field due to the high selectivity and fluxes achievable by membranes, low energy requirements, and simple, easy to operate modules. From the previous study, the formation of TFC membrane over PVDF substrate have a some weakness on the membrane characterization, strength and effectiveness of Polyethersulfone (PES) segment, and the rate of permeability and selectivity of the selected composite membrane Polyethersulfone–Poly (vinylidenefluoride) (PES-PVDF) for mixed CO_2/N_2 at varying pressure and feed concentration at ambient temperature. Now, we introduce method to improved permeability and selectivity for CO_2/N_2 gas separation.

1.3 RESEARCH OBJECTIVES

The first objective of this study are:to develop Poly-vinylidenefluoride (PVDF) membrane. The second objective are to produce thin film composite (TFC) by using Polyethersulfone–Poly (vinylidenefluoride) (PES–PVDF) polymer as membrane support for CO_2/N_2 separation. The last objectives of our research are to study the characteristic and performances of TFC membrane.

1.4 SCOPES OF STUDY

In order to achieve the objectives, the following scopes have been identified:

i. Study on production of TFC membrane preparation.

ii. Study on performances of TFC membrane for CO_2/N_2 gas separation using single gas permeation rig.

iii. Study on characteristics of the TFC membrane by using SEM and FTIR.

1.5 RATIONALE & SIGNIFICANCE

The rational of this study is to get the potential of (PES–PVDF) as basic polymers for TFC membrane development. The key problems are related to the selectivity/permeability ratio and the stability under process conditions. For such special polymers, which may have high cost, the manufacturing of thin film composite membranes and the processing of the polymer preparation from dope solutions, should

be possible. Besides that, the production of TFC can be increased. Hence, it can give the beneficial to the company. In addition to the power generation industry, there have a number of different point sources which produce large CO_2 emissions. CO_2/ N_2 separation membranes can be used to create oxygen enriched air, which can be used in combustion, to get concentrated CO_2 flue gases.